Asphalt Production

Asphalt Production

Hot-mix asphalt is produced in an asphalt plant where the required types and sizes of aggregate are heated to mixing temperature and blended with asphalt cement in the correct proportions.

Asphalt plants generally fall into two categories: batch plants and drum plants. Batch plants make asphalt one batch (truckload) at a time while drum plants can make asphalt continuously and store it until it is needed.

Asphalt Plants

Batch Plant

Produces asphalt one batch at a time
Relatively low production capacities
Easy to change to a new mix as needed

Drum Plant

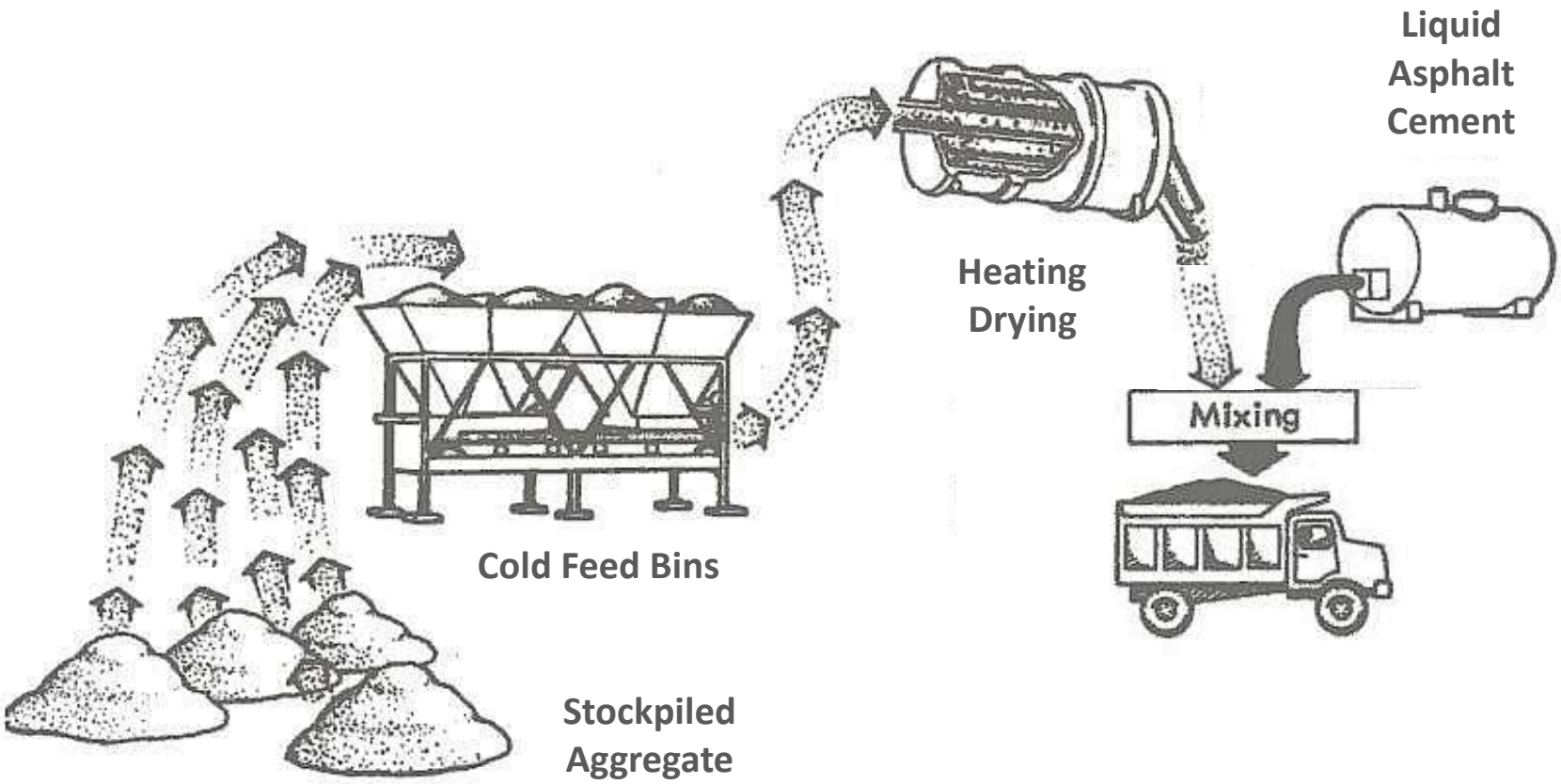
Produces asphalt continuously
Very high production capacities
Storage silos hold accumulated mix

Asphalt Plants

Regardless of the type of plant, the material flow is basically the same. Aggregate from the stockpiles in the yard is loaded into ***cold feed bins*** by front-end loaders. From there the cold aggregate is metered out onto a conveyor belt that transports it to a rotating drum equipped with a powerful burner where it is dried of all moisture and heated to the proper mixing temperature. Then the correct amount of liquid (hot) asphalt cement is mixed in and the resulting asphalt concrete is ready to go to the job site or to a storage silo for later use.

Material Flow

(Taken from The Asphalt Institute Manual ES-1, Second Edition)



Asphalt Plants

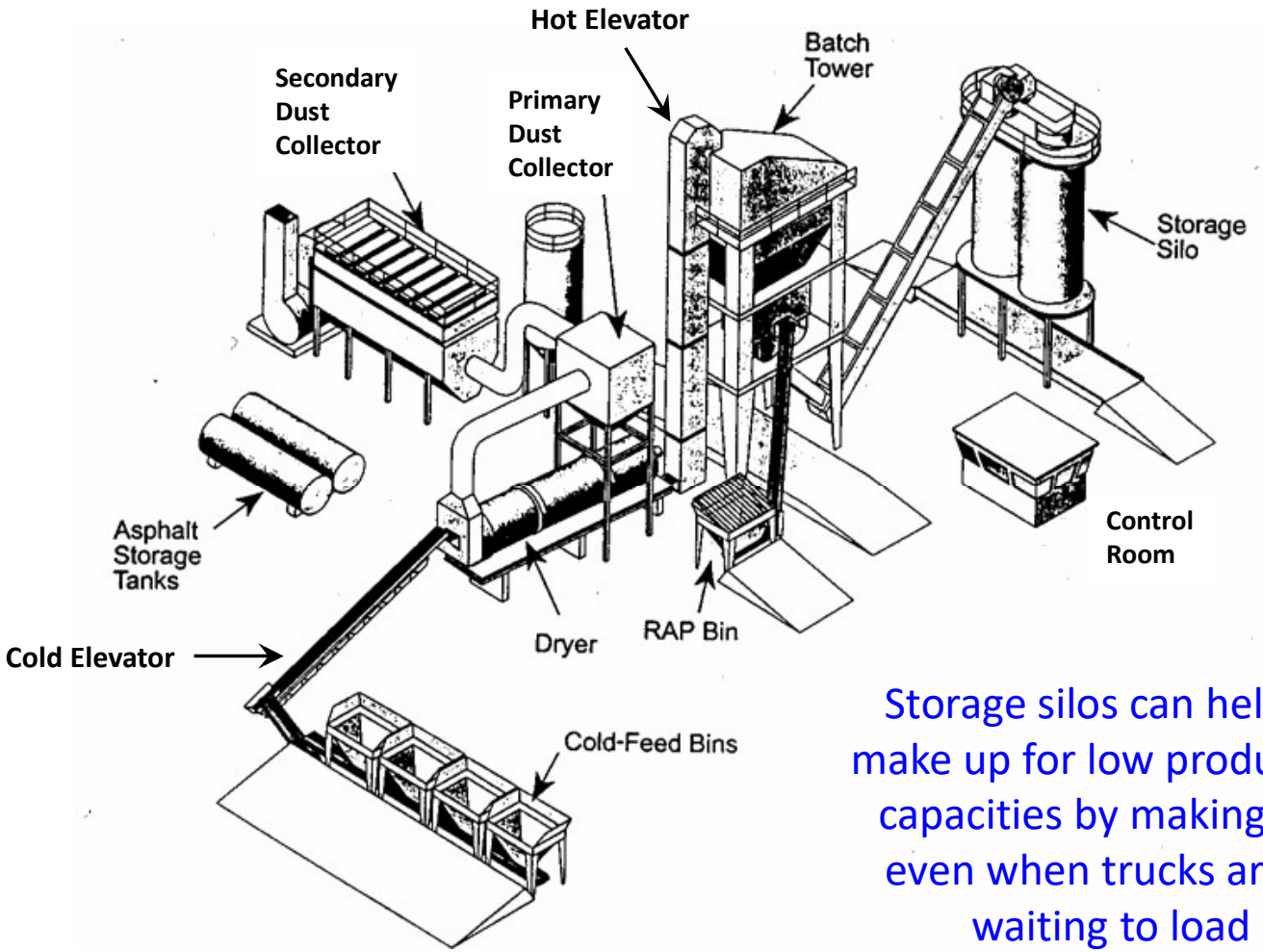
Large asphalt plants that make many different types of asphalt concrete for many different types of paving job may have a dozen or more aggregate stockpiles. There may be crushed stone in several different sizes (No. 57, No. 67, No. 7, etc.), natural sand, manufactured sand, crushed stone screenings, and so on.

Material Stockpiles

Batch Plants

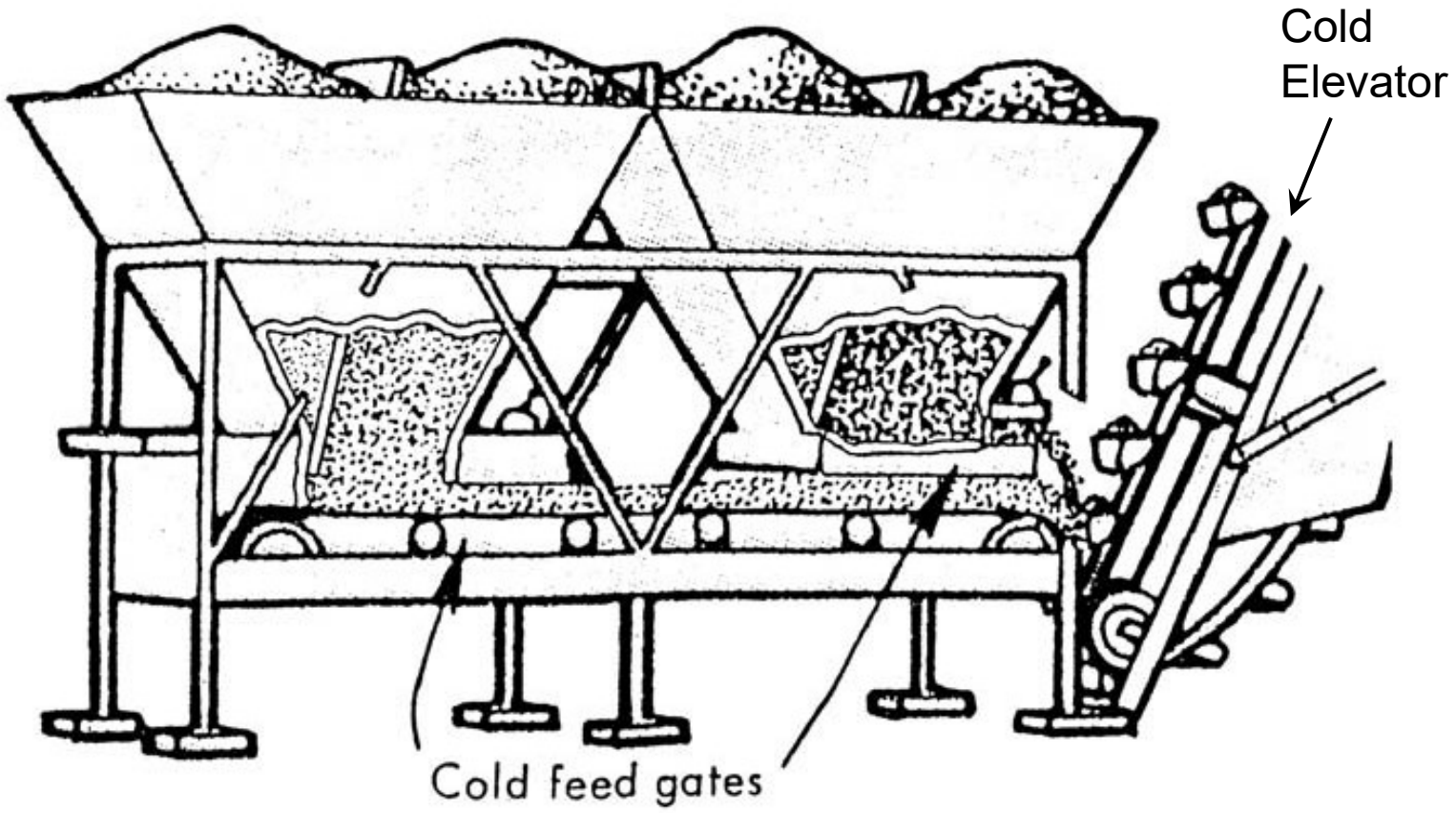
A typical batch plant consists of cold-feed bins, a dryer drum equipped with dust collectors, and a batch tower. In the batch tower, the hot aggregate is deposited in a weigh box in the exact right proportions to reproduce the job mix gradation for a single batch. The aggregate is then dropped into a mixer where the liquid asphalt cement is added and blended in. The finished asphalt concrete mix is then dropped into a waiting dump truck or sent to a heated storage silo until it is needed.

Batch Plant



Storage silos can help to make up for low production capacities by making mix even when trucks aren't waiting to load

Cold Feed Bins

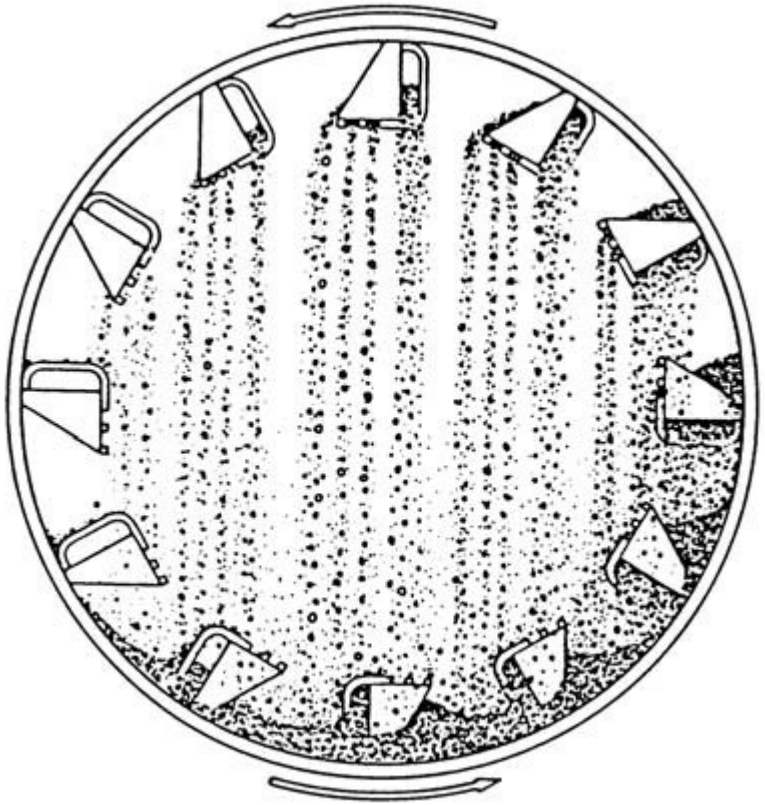


Aggregate Dryer

Dryer

The walls of the dryer contain a series of buckets that scoop up the aggregate on the bottom of the drum and dump it out at the top of the drum. In this way, the aggregate continuously falls through the hot burner gases traveling from one end of the drum to the other.

Dryer Cutaway

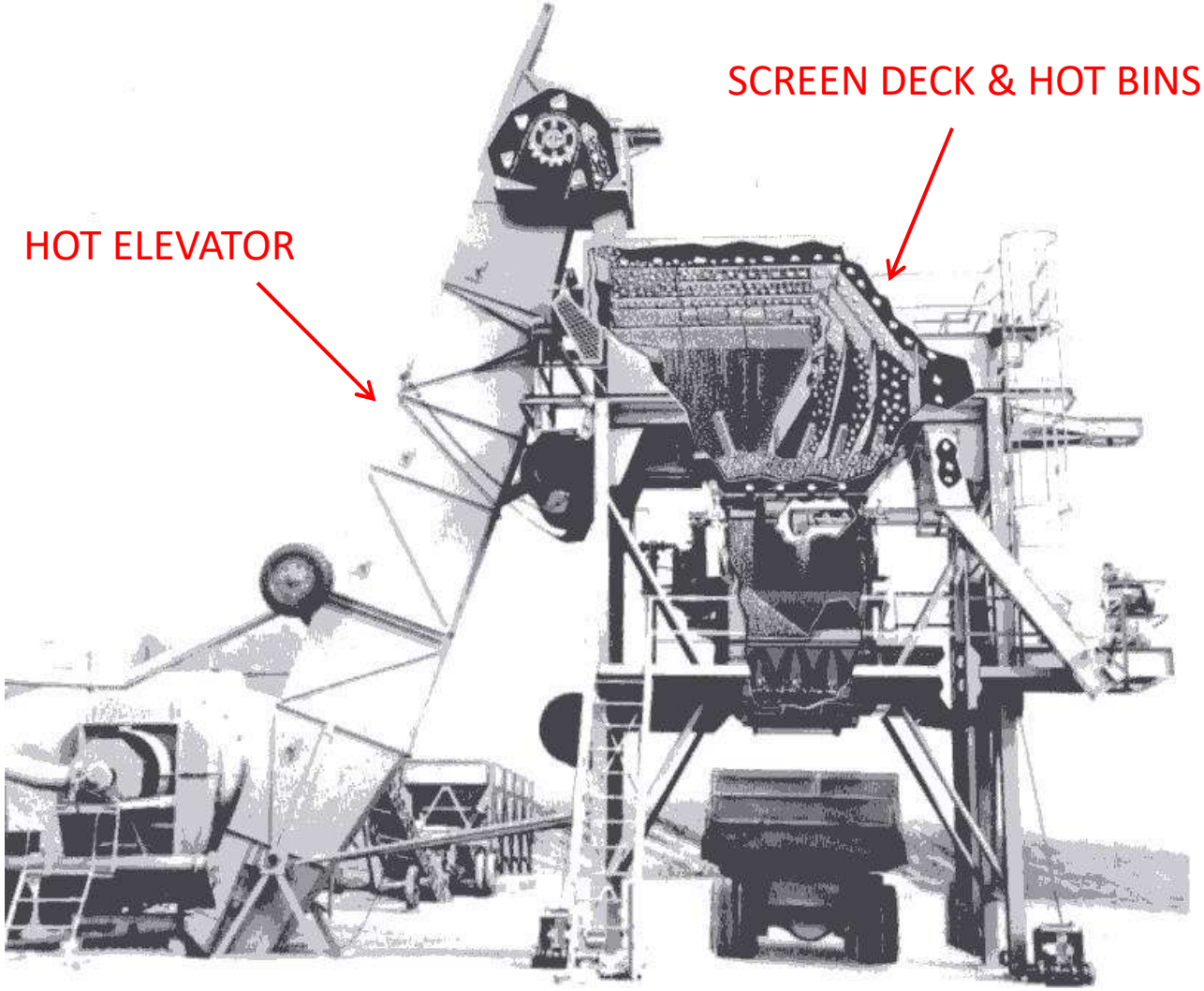


Mixing Tower

When the aggregate enters the mixing tower, it passes through a series of vibrating screens that separate it into different size fractions. The aggregate blend is then reassembled in the weigh box in the exact proportions called for in the mix design. This helps alleviate problems with aggregate segregation.

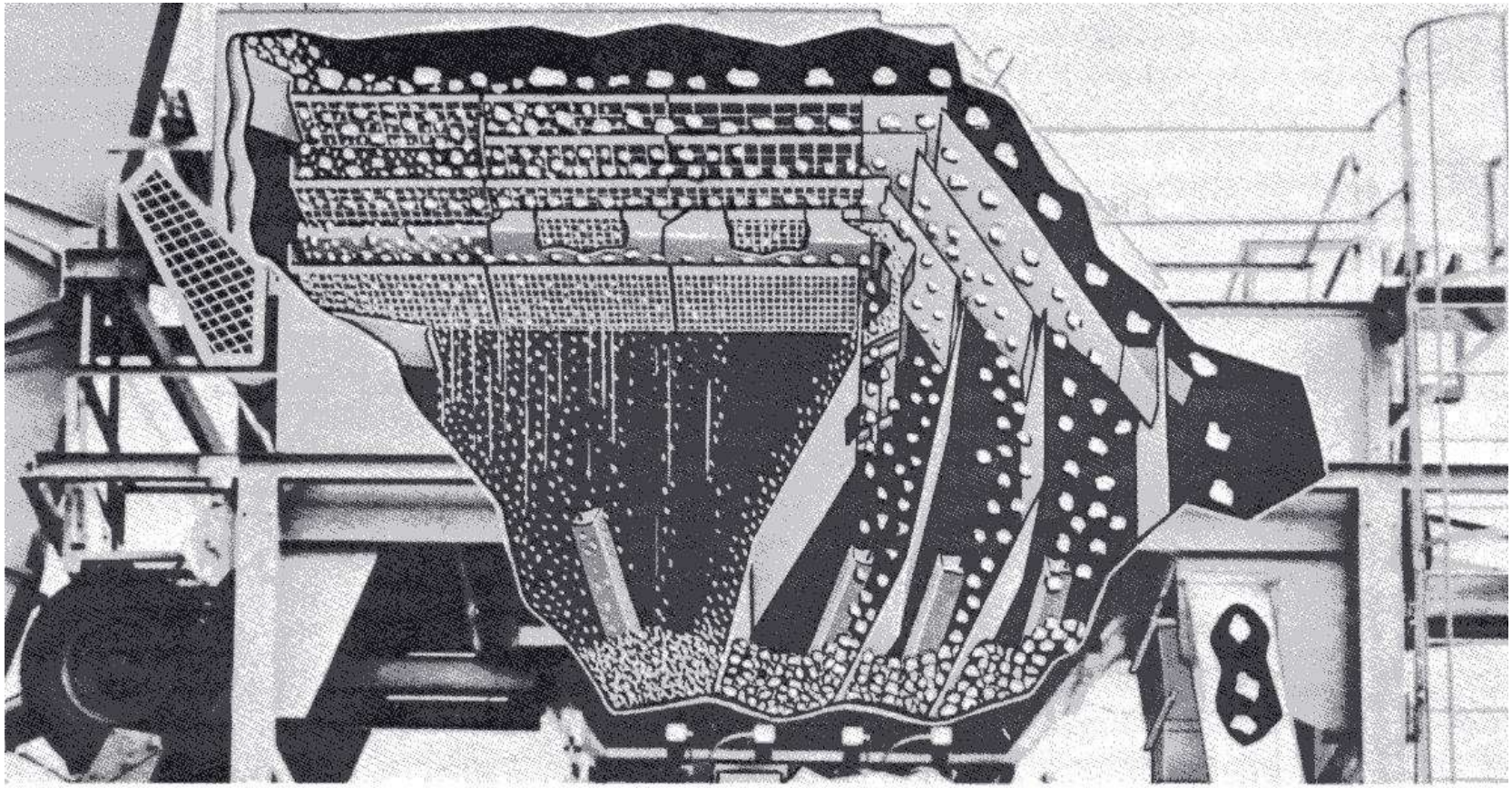
Mixing Tower Cutaway

(Taken from The Asphalt Institute Manual ES-1, Second Edition)



Screen Deck & Hot Bins

(Taken from The Asphalt Institute Manual ES-1, Second Edition)

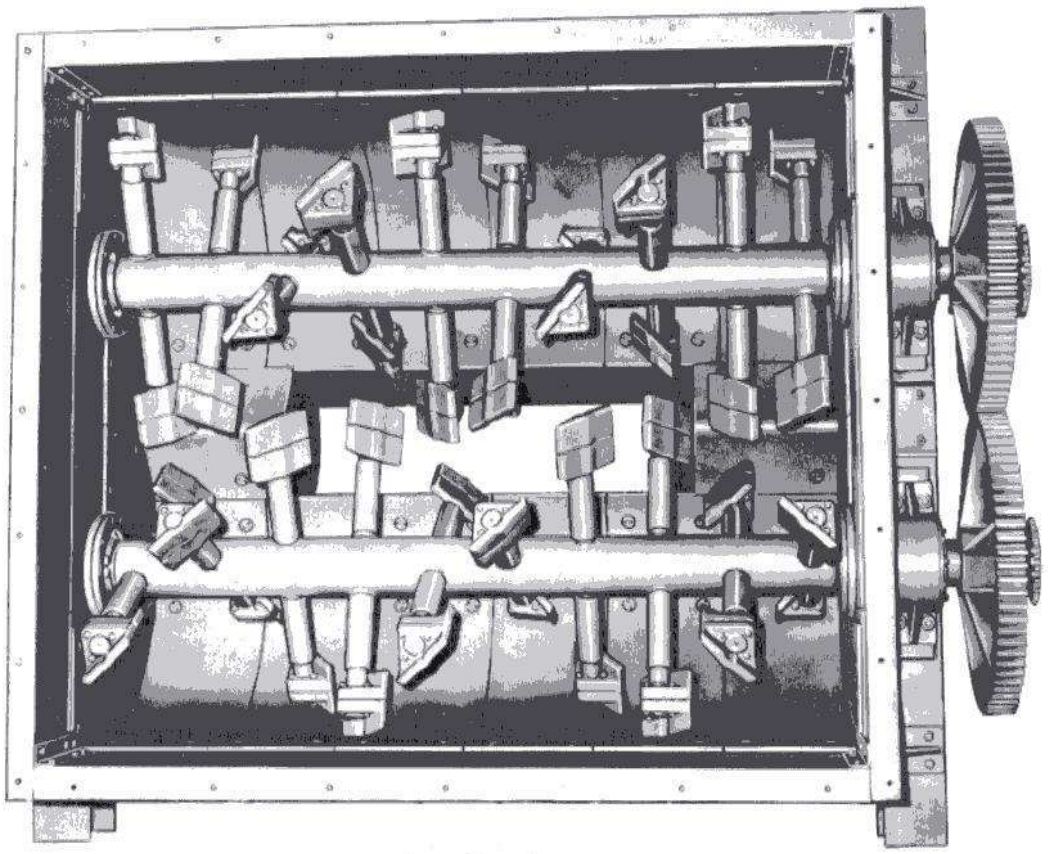


Batch Plants

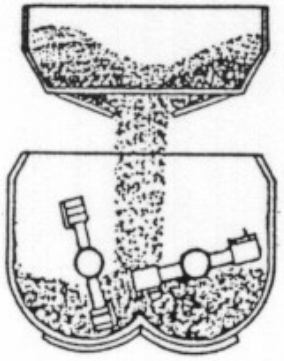
As soon as the correct aggregate blend is assembled in the weigh box, it is dropped into a pugmix mixer, briefly mixed dry to achieve a homogeneous blend, then hot liquid asphalt cement is sprayed on the aggregate in the correct amount. A bit more mixing to ensure the aggregate is completely coated with asphalt cement and this batch of asphalt concrete is done. The entire process takes 30 seconds or less.

Pugmill Mixer

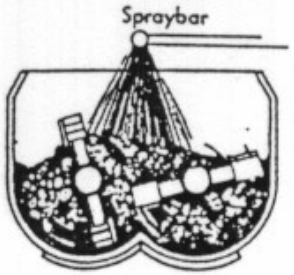
(Taken from The Asphalt Institute Manual ES-1, Second Edition)



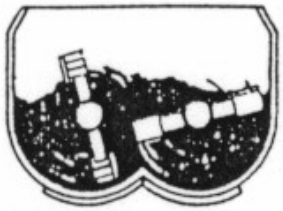
Typical Mixing Cycle



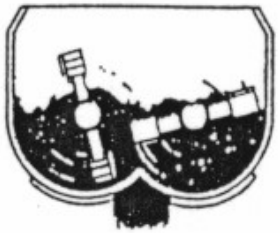
1. Aggregate enters pugmill from weigh box



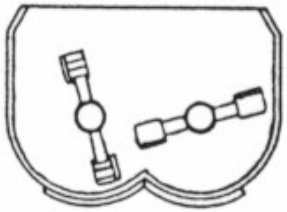
2. Asphalt cement enters pugmill from spraybar



3. Aggregate and asphalt cement are mixed



4. Finished mix discharged through pugmill gate



5. Pugmill gate closes to receive the next batch

Batch Plants

Smaller batch plants only make asphalt when a dump truck drives up to receive material. This makes them very flexible (each batch can have a completely different mix design) but their production volumes are low.

Larger batch plants use silos to store mix. That way, the plant doesn't have to wait for the next truck to arrive to produce the next batch of asphalt concrete; it can use the downtime between trucks to keep making asphalt and fill the silos, which keeps the mix hot until needed.

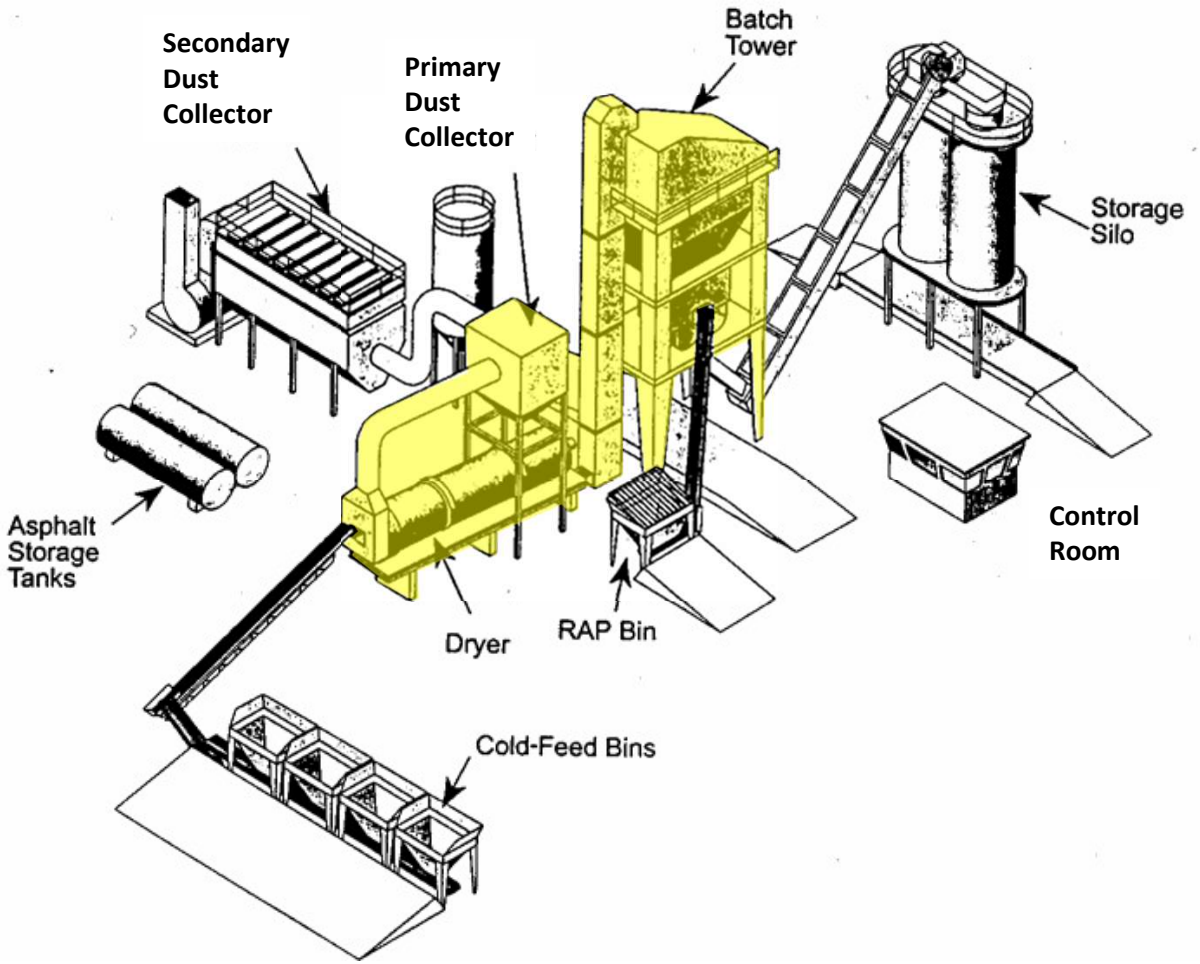
Storage Silos

Heated silos can store asphalt for up to 4 days

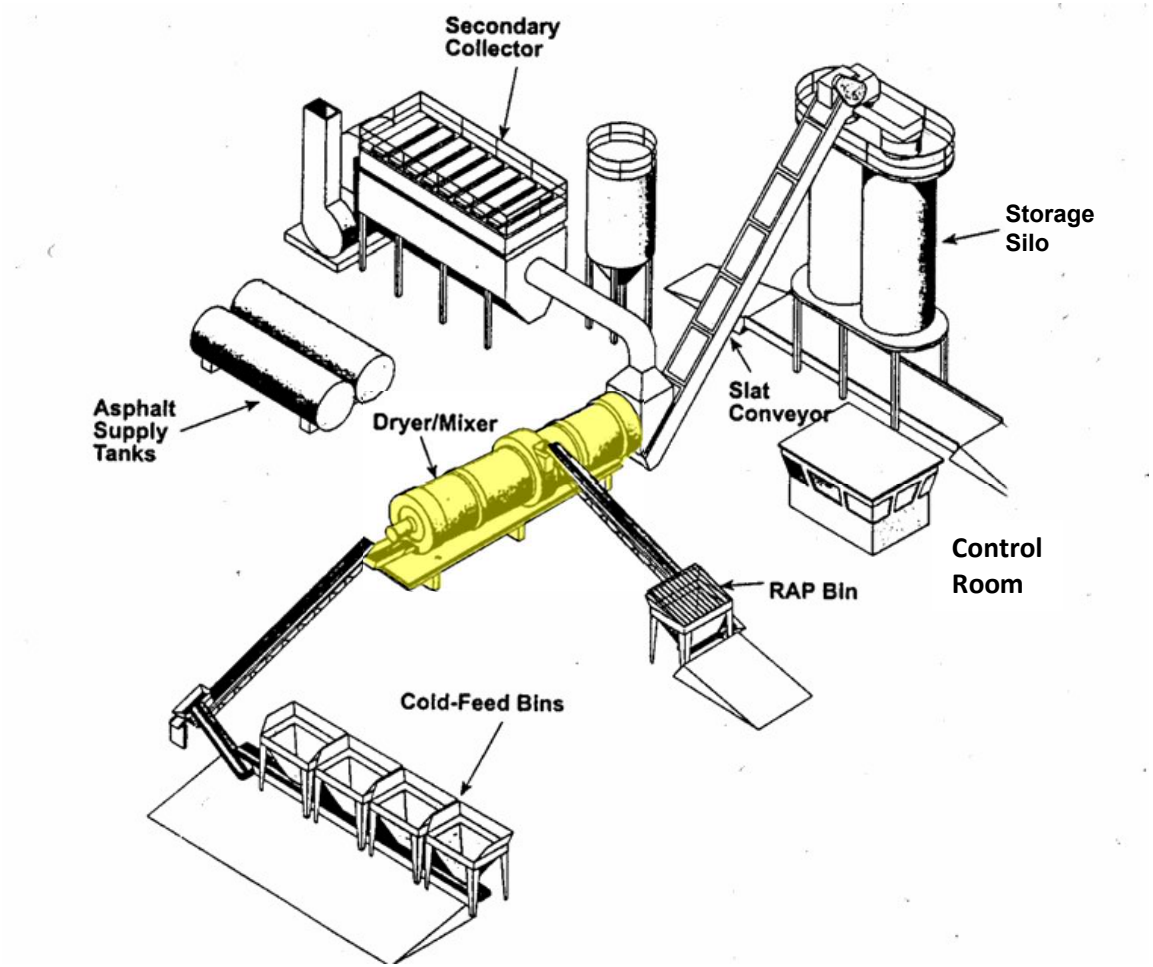
Drum Plants

Drum plants combine the dryer and mixing tower into a single drum that dries the aggregate, heats it to mixing temperature, adds the asphalt cement, mixes it with the aggregate, then deposits the finished product onto a conveyor that takes it to the storage silo. And it does all of that continuously.

Batch Plant


Secondary Dust Collector
Primary Dust Collector
Batch Tower
Storage Silo
Asphalt Storage Tanks
Dryer
RAP Bin
Control Room
Cold-Feed Bins

Drum Plant


Secondary Collector
Storage Silo
Asphalt Supply Tanks
Dryer/Mixer
Slat Conveyor
Control Room
RAP Bin
Cold-Feed Bins

Drum Plants

This is achieved by using computer control and “weigh bridges” that instantaneously weigh the aggregate as it enters the dryer/mixer drum. The computer knows how long it will take the aggregate to get from one end of the drum to the other, so it can apply just the right amount of asphalt cement to the aggregate when it reaches the spray bar.

Drum Plants

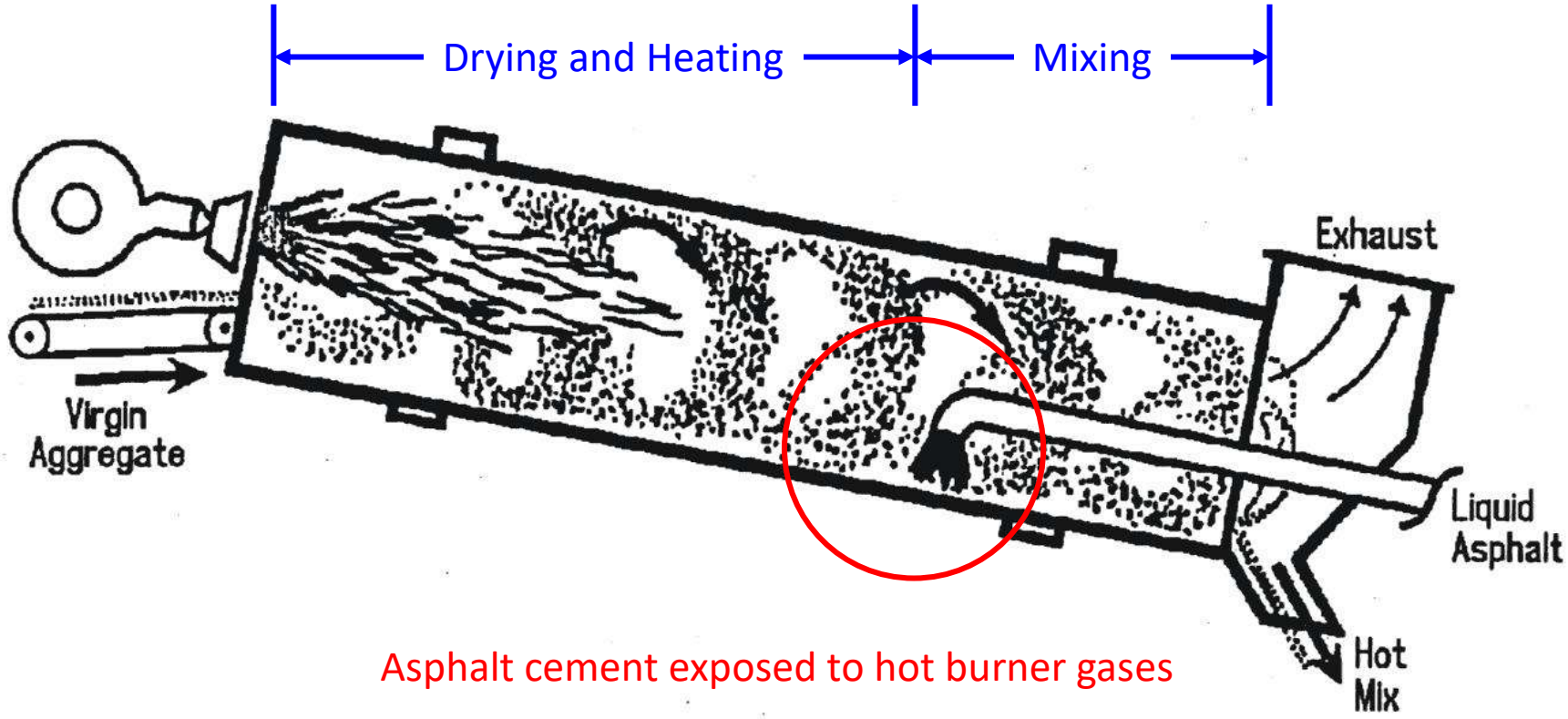
Drum plants can have very high production volumes because they never have to stop (at least until the silos are filled). The downside is that they can only make one mix design at a time. They can switch mixes on the fly, but they have to waste all of the material that passes through the plant as the changeover occurs because it doesn't meet the old or the new design. As a result, the plant switches mixes infrequently. This makes them much less flexible than batch plants.

Parallel-Flow Drum Plant

The original drum plants used a parallel-flow design where the aggregate travelled through the drum in the same direction as the burner gases. This could cause the asphalt cement to be overheated (the burner gases can reach 600°F) and volatilize excessively. It would also cause the plant to emit a lot of blue smoke due to the burning of the oils in the asphalt cement. This was back in the 1970s when the Clean Air Act was being passed and a lot of communities didn't want this pollution in their midst.

Parallel-Flow Drum Plant

(Taken from The U. S. Army Corps of Engineers *Hot Mix Paving Handbook*)



Asphalt cement exposed to hot burner gases

Counter-Flow Drum Plant

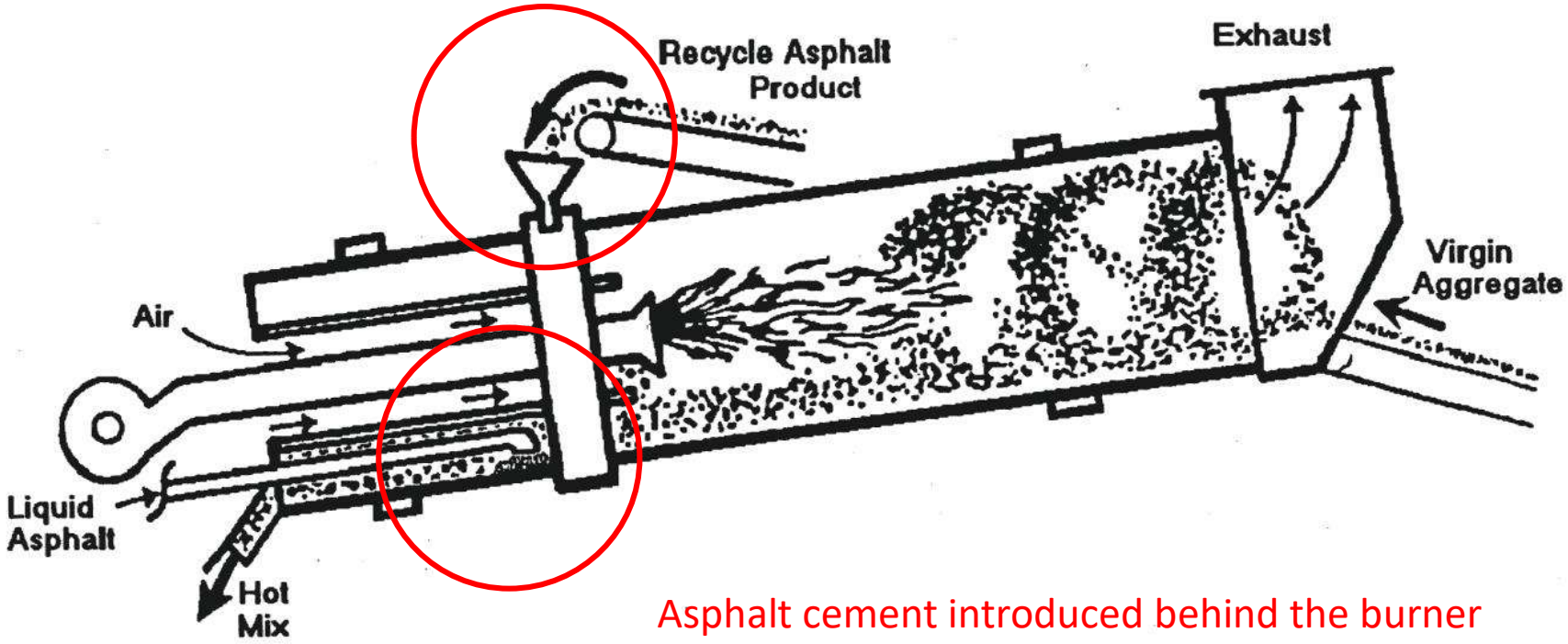
Some of these problems were fixed by counter-flow plants where the burner was moved to the low end of the drum and moved closer to the aggregate entrance. In these plants the aggregate and burner gases flowed in opposite directions, hence the name.

The advantage of these plants is that the asphalt cement (and any recycled asphalt product, if it is being used) is introduced behind the burner nozzle. This eliminates burning of the volatiles in the asphalt cement.

Counter-Flow Drum Plant

(Taken from The U. S. Army Corps of Engineers *Hot Mix Paving Handbook*)

RAP introduced behind the burner



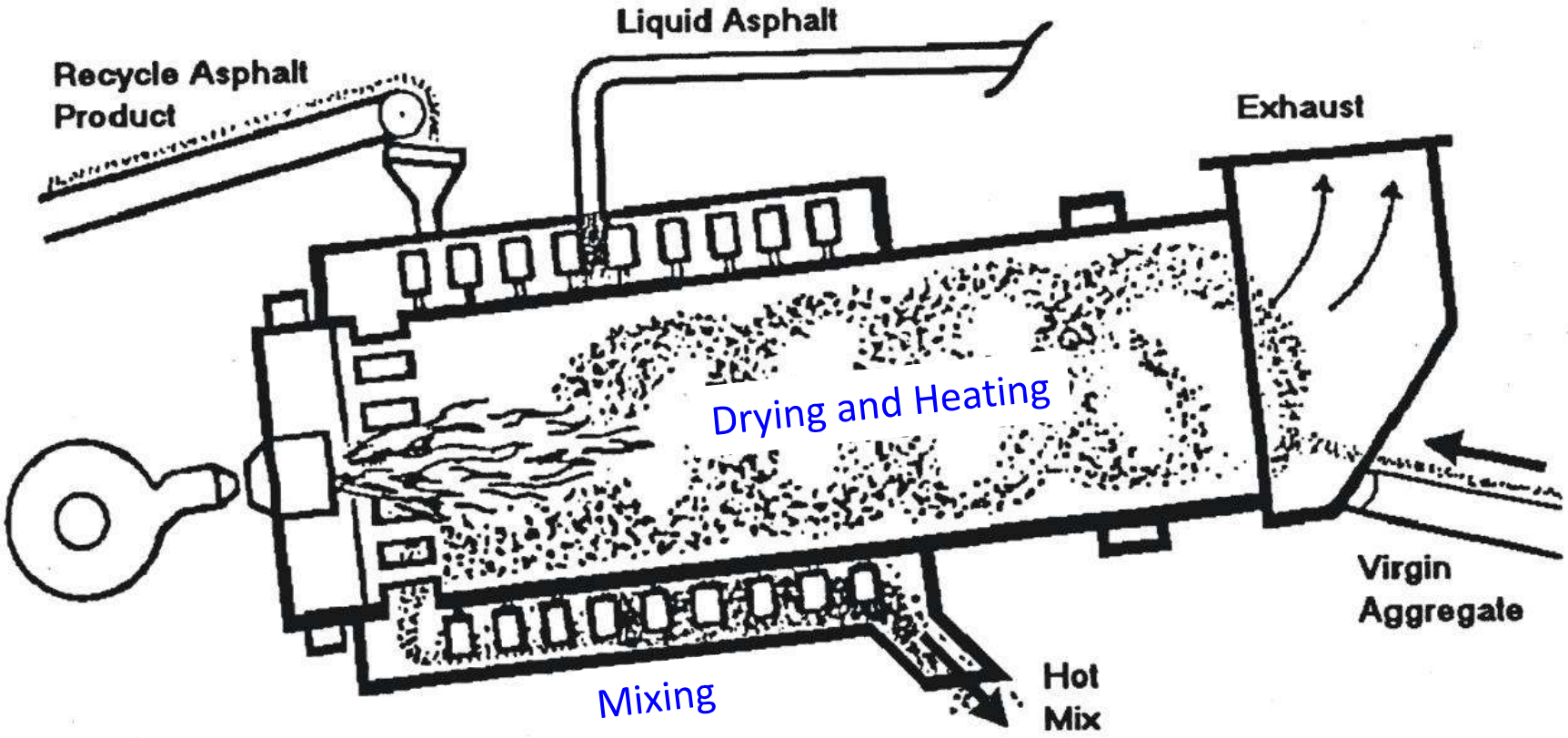
Asphalt cement introduced behind the burner

Double-Drum Plant

Soon after their introduction, counter-flow drum plants were supplanted with yet another design: double-drum plants. These completely separate the asphalt cement and RAP from the burner gases by drying and heating the aggregate in an inner drum, then mixing it with the asphalt cement and RAP in the annulus between the inner drum and an outer drum. Because the drum is, in a sense, folded over on itself, these plants are much more compact than a traditional drum plant.

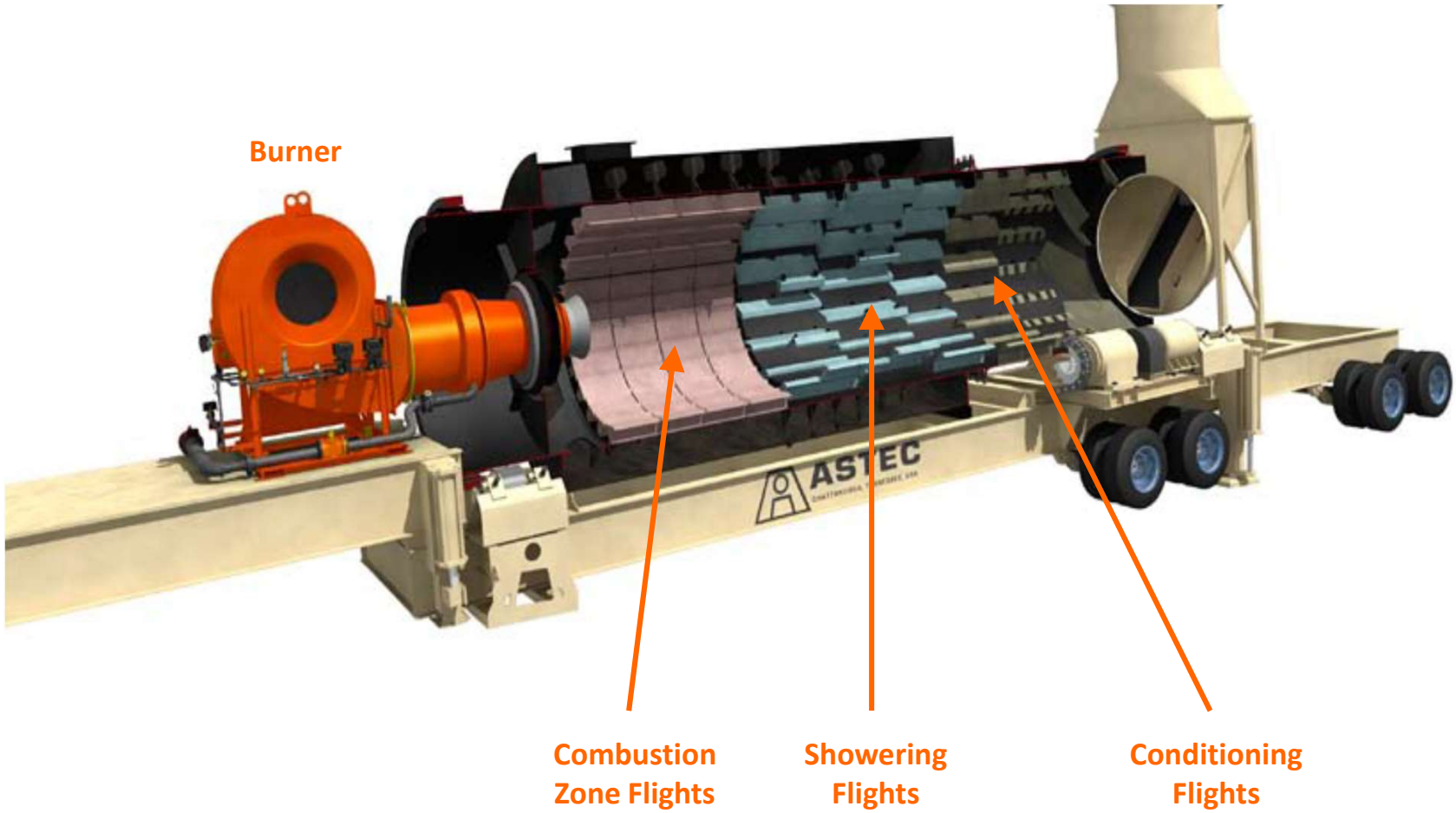
Double-Drum Plant

(Taken from The U. S. Army Corps of Engineers *Hot Mix Paving Handbook*)



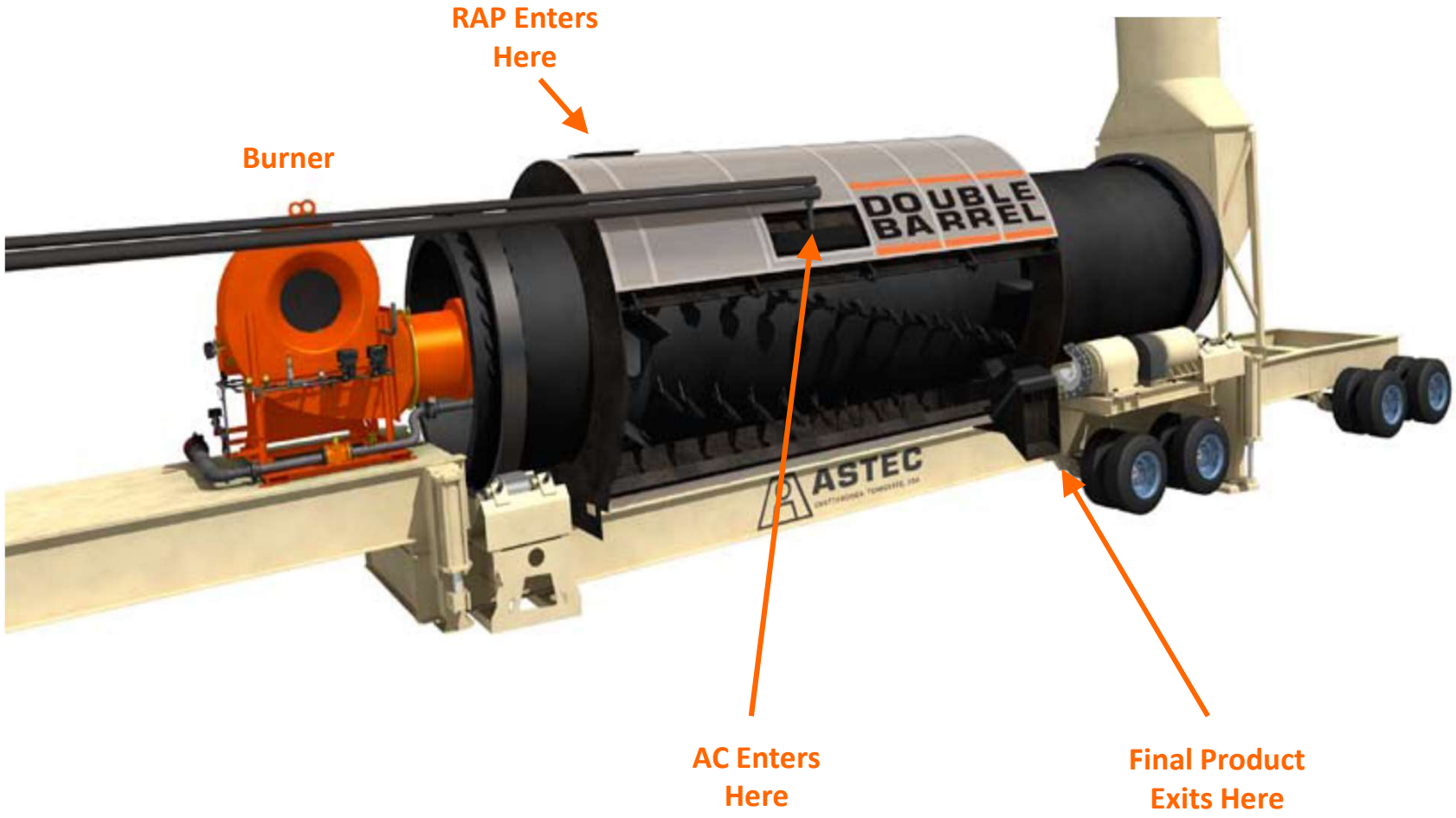
Double-Drum Plant

(Taken from The ASTEC Double-Barrel Brochure)



Double-Drum Plant

(Taken from The ASTEC Double-Barrel Brochure)



Drum Plants

Some drum plants are made to be portable so they can be moved from one job site to another to reduce travel times between the plant and the job site and maintain the temperature of the asphalt until it is laid.

The plant in the next slide has four cold feed bins, a drum mixer (the black cylinder), a baghouse for dust collection, and a single silo for storing product. The large silver cylinder is the liquid asphalt tank and the small windowed cube is the control room.

Portable Drum Plant

Drum Plants

The next slide shows a fixed plant. Like the portable plant in the last slide, it has four cold feed bins, a drum mixer, a baghouse for dust collection, and two silos for storing product. The vertical cylinder in the middle of the picture probably holds lime (which helps prevent stripping) or mineral filler (material passing the No. 100 sieve). You can also see many different aggregate piles with different sizes a couple of black RAP piles.

Fixed Drum Plant

Recycled Asphalt Product

A lot of asphalt concrete used today contains at least some recycled asphalt product (RAP). RAP is asphalt concrete that has been milled off an existing roadway to be recycled into a new asphalt mix.

RAP is good for the environment because (a) it keeps landfills from being filled up with old asphalt and (b) it reduces the amount of virgin aggregate and asphalt cement needed to produce new pavements.

Asphalt Milling

http://www.barbicas.com/asphalt_milling.html

RAP Stockpiles

https://www.worldhighways.com/categories/asphalt-paving-compaction-testing/features/economic-and-environmental-asphalt-recycling/

Recycled Asphalt Product

In modern plants, the RAP is crushed into different sizes so that individual size fractions of the aggregate blend can be replaced with like sizes of RAP. This makes it easier for the augmented mix to have the correct aggregate gradation and allows the use of asphalt mixes with higher RAP percentages without sacrificing quality.

Fractionated RAP

https://www.equipmentworld.com/plant-management-of-raprca/

Hot Mix Asphalt Paving

The Asphalt Paving Train

Once the hot-mix asphalt leaves the asphalt plant, it travels to the job site in a dump truck. If the job site is a long way from the plant, the contractor may use dump trucks with an insulating double-wall construction and an insulating cover to maintain the asphalt temperature.

Once the dump truck arrives on site, it waits its turn to join the paving train. The paving train consists of a dump truck unloading mix into an asphalt paver that is followed by one or more compaction rollers.

THE ASPHALT PAVING TRAIN

1. Asphalt is manufactured in a plant, discharged into the dump truck, and transported to the project location. The mixture is typically heated to a temperature between 275 and 350 degrees Fahrenheit.

2. The truck driver backs up just short of the paver – the driver should be careful not to bump the paver. Once the paver makes contact with the truck, the driver raises the bed. The truck driver applies the brakes gently, and the tractor unit on the paver pushes the truck forward.

3. The truck gate is released, and the asphalt is discharged from the truck into the paver hopper. To avoid segregation of the mixture, the material should be allowed to "flood" the hopper and not "dribble" out of the truck.

4. The asphalt material flows from the hopper along the slat conveyors to the augers and eventually to the screed at the rear of the paver. A continuous, non-stop paving process ensures a quality product.

5. The dump man uses hand signals to direct the truck driver's location and when and how much to raise and lower the truck bed.

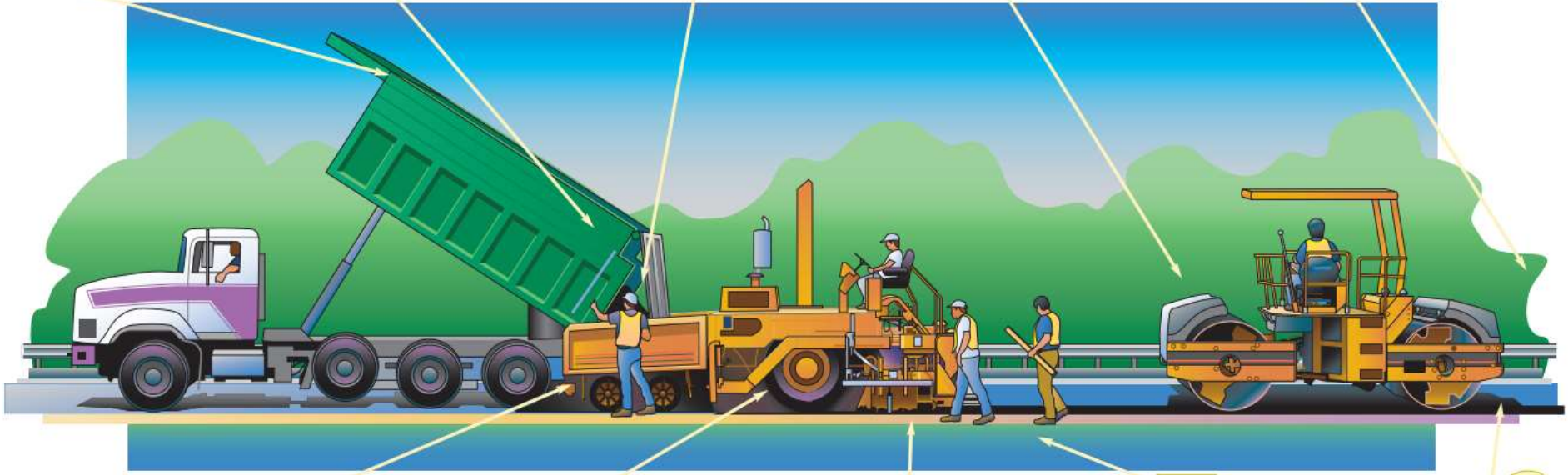
6. The free-floating (self-leveling) screed unit strikes off the material to create a smooth mat and provides initial compaction of the mixture. The screed also sets thickness, width and creates a smooth, uniform mat.

7. Paving crew members monitor the mixture for temperature and thickness and perform raking when necessary. Thin resurfacing may be accomplished in one pass, but thicker sections (for rehabilitation or new construction) may require multiple passes of the paver.

8. The first roller is called the "breakdown roller" and provides the primary compaction (95 percent or more of specified density) of the mixture by applying weight – and sometimes vibration – to the mat.

9. Most contractors will have two or three rollers on a project. The second roller is called the "intermediate roller" and provides the balance of the required density to the mixture. The final roller is called the "finish roller," and its purpose is to remove any remaining roller marks and provide smoothness to the pavement.

10. Behind the rolling operation, quality control technicians from the contractor will typically perform density testing or obtain core samples from the roadway. Asphalt pavements are typically ready for traffic once the mixture has cooled below 150 degrees - usually in a few short hours.



PAIKY
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Tel (502) 223-3415 Fax(502) 223-2370 e-mail: info@paiky.org www.paiky.org

The Asphalt Paving Train

The Asphalt Paving Train

The dump truck backs up to the paver and discharges its load into the paver's hopper. A slat conveyor draws the asphalt from the hopper to the back of the paver where an auger spreads the asphalt across the width of the paving lane and deposits it on the roadbed at the specified thickness.

Asphalt Paver

Asphalt Paver

Asphalt Paver Hopper

Source: PTC Pavement Guide Interactive

Asphalt Paver Slat Conveyor

Source: PTC Pavement Guide Interactive

The Asphalt Paving Train

A vibrating screed then provides the initial compaction to the asphalt mat (to about 85% of the required final density) and assures the mat has the correct width and thickness. It can also vary the thickness of the mat from side to side to provide a proper crown to the road so rain drains off to the sides of the road.

The screed may be equipped with extensions that allow mat widths much greater than the width of the paver itself.

Asphalt Paver Screed

Provides about 85% of the final compaction density

Asphalt Paver
Vibrating Screed

Asphalt Paver Screed

Source: https://www.forconstructionpros.com/

The Asphalt Paving Train

Immediately behind the paver is the breakdown roller. This is usually a heavy steel-wheeled roller, often with added vibration, that compacts the mat to around 95% of the required density. Remember that dense-graded aggregate is hard to compact, which is why vibratory rollers are often used in asphalt paving. The vibration helps the particles to settle into a denser configuration.

Vibratory Breakdown Roller

The Asphalt Paving Train

The breakdown roller is followed by an intermediate roller the completes the densification of the mat. This is often a pneumatic tire roller that “kneads” the asphalt to provide better asphalt compaction.

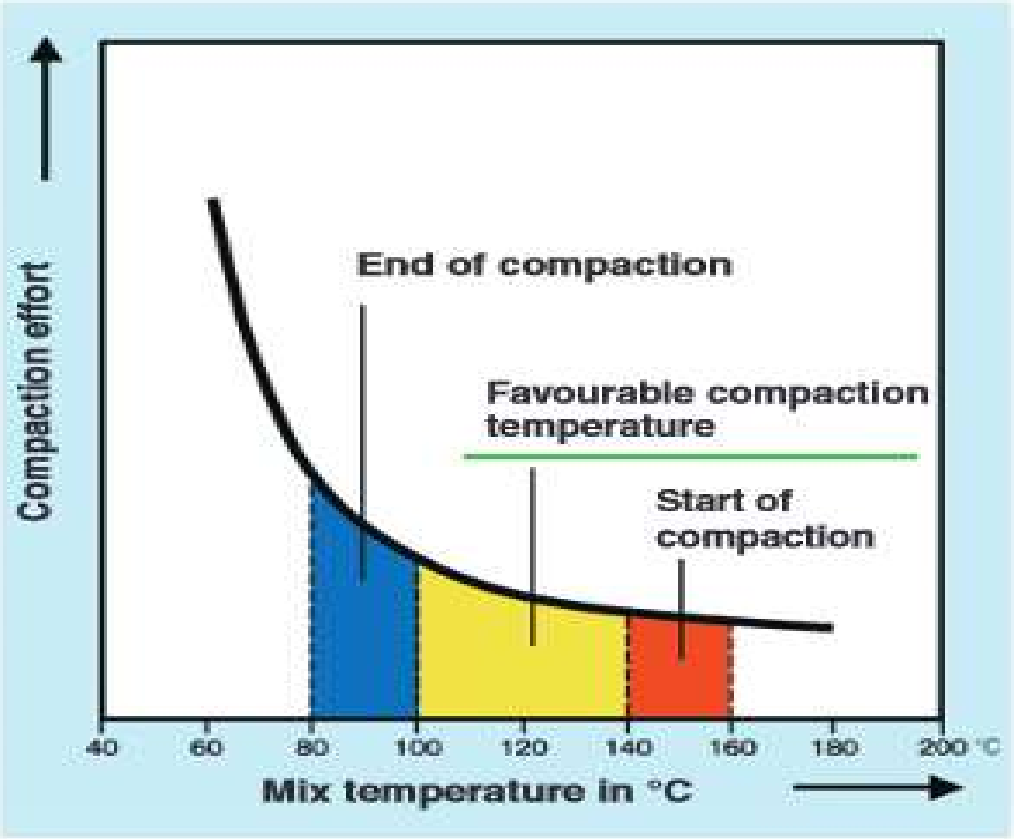
The last roller in the train is a steel-wheeled finishing roller that smooths out any imperfections left by the intermediate roller (especially if it is a pneumatic tire roller) and completes the pavement.

Intermediate and Finishing Rollers

Asphalt Compaction

The rollers are carefully sequenced so they complete their portion of the operation while the temperature of the asphalt is still high enough to get good compaction. If the asphalt cools off too much, it won't achieve the proper density and the pavement longevity will suffer. On the other hand, if it hasn't cooled enough, it may be tender and difficult to compact to the right density. So roller sequencing is crucial to a good finished product.

Asphalt Compaction



Material Transfer Vehicle

Increasingly, state highway agencies are employing something called a material transfer vehicle between the dump truck and the paver. This vehicle, invented in 1989 by Astec Industries in Chattanooga, remixes the asphalt before it goes to the paver and provides surge capacity so the paver can keep moving even if the next load of asphalt is delayed.

Material Transfer Vehicle

Studies have shown that potholes in new pavements correlate with the temperature of the asphalt when it is placed. Everywhere there is a cold spot, a pothole will develop due to inadequate compaction of the mix.

The MTV evens out temperature differences by remixing the asphalt. It also helps with aggregate segregation, which occurs when coarse aggregate tends to migrate to the sides of the dump truck bed during transit.

Material Transfer Vehicle

The surge capacity is important because the paver must always be moving to provide a uniform mat thickness. Starts and stops cause bumps in the pavement. In order for the paver to keep moving, it must always have a truckload of asphalt waiting to be discharged. The MTV holds a truckload or more of asphalt, so it can keep feeding the paver while it waits for the next dump truck to show up.

Paving Train with MTV

Material Transfer Vehicle